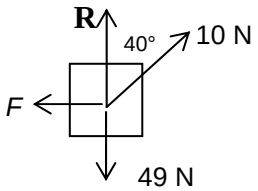
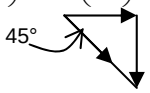
Q 1		mark		sub
	either			
		M1	Attempt at area. If not trapezium method at least one part area correct. Accept equivalent.	
	$70V$ obtained	A1	Or equivalent – need not be evaluated.	
	So $70V = 1400$	M1	Equate **their** $70V$ to 1400. Must have attempt at complete areas or equations.	
	and $V = 20$	A1	cao	
	or	M1	Attempt to find areas in terms of ratios (at least one correct)	
		A1	Correct total ratio – need not be evaluated. (Evidence may be 800 or 400 or 200 seen).	
		M1	Complete method. (Evidence may be 800/40 or 400/20 or 200/10 seen).	
	$V = 20$	A1	cao [Award 3/4 for 20 seen WWW]	
				4

Q 2		mark		sub
	$(v =)12 - 3t^2$	M1	Differentiating	
		A1	Allow confusion of notation, including $x =$	
	$v = 0 \Rightarrow 12 - 3t^2 = 0$	M1	Dep on 1st M1. Equating to zero.	
	so $t^2 = 4$ and $t = \pm 2$	A1	Accept one answer only but no extra answers. FT only if quadratic or higher degree.	
	$x = \pm 16$	A1	cao. Must have both and no extra answers.	
				5

Q 3		mark		sub
(i)	$R = mg$ so 49 N	B1	Equating to weight. Accept $5g$ (but not mg)	1
(ii)		B1	All except F correct (arrows and labels) (Accept mg, W etc and no angle). Accept cpts instead of 10N. No extra forces.	
		B1	F clearly marked and labelled	2
(iii)	$\uparrow \quad R + 10\cos 40 - 49 = 0$	M1	Resolve vertically. All forces present and 10N resolved	
		B1	Resolution correct and seen in an equation. (Accept $R = \pm 10\cos 40$ as an equation)	
	$R = 41.339\ldots$ so 41.3 N (3 s. f.)	A1		
	$F = 10\sin 40 = 6.4278\ldots$ so 6.43 N (3 s. f.)	B1	Allow –ve if consistent with the diagram.	4
				7

Q 4		mark		sub
(i)	$\downarrow \quad 20+16\cos 60=28$	B1		1
(ii)	**either** $\rightarrow 16\sin 60$ Mag $\sqrt{28^2+192}=31.2409...$ so 31.2 N (3 s.f.) **or** Cos rule $\text{mag}^2=16^2+20^2-2\times16\times20\times\cos120$ 31.2 N (3 s. f.)	B1 M1 F1 M1 A1 A1	Any form. May be seen in (i). Accept any appropriate equivalent resolution. Use of Pythag with 2 distinct cpts (but not 16 and $\pm$ 20) Allow 34.788… only as FT Must be used with 20 N, 16 N and 60° or 120° Correct substitution	3
(iii)	Magnitude of accn is 15.620… m s^{-2} so 15.6 m s^{-2} (3 s. f.) angle with 20 N force is $\arctan\left(\frac{16\sin 60}{28}\right)$ so 26.3295… so 26.3° (3 s. f.)	B1 M1 A1	Award only for **their** $F\div2$ Or equiv. May use force or acceleration. Allow use of sine or cosine rules. FT only $\text{s}\leftrightarrow\text{c}$ and sign errors. Accept reciprocal of the fraction. cao	3
				7

Q 5		mark		sub
(i)	 sphere $19.6-T=2a$ block $T-14.8=4a$	M1 A1 A1	N2L. All forces attempted in one equation. Allow sign errors. No extra forces. Don't condone $F=mga$. Accept 2g for 19.6	3
(ii)	Solving T = 18 a = 0.8	M1 A1 F1	Attempt to solve. Award only if two equations present both containing a and T. Either variable eliminated. Either found cao Other value. Allow wrong equation(s) and wrong working for 1st value [If combined equation used award: M1 as in (i) for the equation with mass of 6 kg; A1 for a = 0.8; M1 as in (i) for equation in T and a for either sphere or block; A1 equation correct; F1 for T, FT **their** a; B1 Second equation in T and a.]	3
				6

Q 6		mark		sub
(i)	$t = 2.5 \Rightarrow \mathbf{v} = \begin{pmatrix} -5 \\ 10 \end{pmatrix} + 2.5\begin{pmatrix} 6 \\ -8 \end{pmatrix} = \begin{pmatrix} 10 \\ -10 \end{pmatrix}$	B1	Need not be in vector form	
		E1	Accept diag and/or correct derivation of just $\pm 45°$	
	speed is $\sqrt{10^2 + 10^2} = 14.14...$ so 14.1 m s^{-1} (3 s. f.)	F1	FT **their v**	3
(ii)	$\mathbf{s} = 2.5\begin{pmatrix} -5 \\ 10 \end{pmatrix} + \frac{1}{2} \times 2.5^2 \times \begin{pmatrix} 6 \\ -8 \end{pmatrix}$	M1	Consideration of **s** (const accn or integration)	
		A1	Correct sub into *uvast* with **u** and **a.** (If integration used it must be correct but allow no arb constant)	
	$= \begin{pmatrix} 6.25 \\ 0 \end{pmatrix}$	A1		
	so 090°	A1	cao. CWO.	4
				7

Q 7		mark		sub
(i)	acceleration is $\frac{24}{12}$ so 2 m s^{-2}	B1		1
(ii)	$24-15=12a$ a = 0.75 m s^{-2} 1st distance is $0.5\times2\times16=16$ 2nd distance is $0.5\times0.75\times16=6$ Difference is 10 m	M1 A1 M1 A1 A1	Use of N2L. Both forces present. Must be $F = ma$. No extra forces. Appropriate *uvast* applied at least once. Need not evaluate. Both found. May be implied. FT (i) cao	5
(iii)	$12g\sin5-15=12a$ $a=-0.39587...$ so – 0.396 m s^{-2} (3 s. f.)	M1 M1 A1 A1	Use of $F = ma$, allow 15 N missing *or* weight not resolved. No extra forces. Allow use of $12\sin5$. Attempt at weight cpt. Allow sin $\leftrightarrow$ cos. Accept seen on diagram. Accept the use of 12 instead of 12g. Weight cpt correct. Accept seen on diagram. Allow not used. Correct direction must be made clear	4
(iv)	time $0=1.5+at\Rightarrow t=3.789...$ so 3.79 s (3 s. f.) distance $s=0.5\times(1.5+0)\times3.789...$ (or…) giving s = 2.8418… so 2.84 m (3 s. f.)	M1 A1 M1 A1	Correct *uvast* . Use of 0, 1.5 and **their** a from (iii) or **their** s from (iv). Allow sign errors. Condone $u\leftrightarrow v$. Correct *uvast* . Use of 0, 1.5 and **their** a from (iii) or **their** t from (iv). Allow sign errors. Condone $u\leftrightarrow v$. [The first A1 awarded for t or s has FT **their** a if signs correct; the second awarded is cao]	4
(v)	accn is given by $0=1.5+3.5a\Rightarrow a=-\frac{3}{7}=-0.42857...$ $12g\sin5-R=12\times-0.42857...$ so R = 15.39… so 15.4 N (3 s. f.)	M1 A1 M1 A1	Use of 0, 1.5 and 3.5 in correct *uvast.* Condone $u\leftrightarrow v$. Allow $\pm$ N2L. Must use **their** *new* accn. Allow only sign errors. cao	4
				18

Q 8		mark		sub
(i)	Using $s = ut + 0.5at^2$ with u = 10 and a = -10	E1	Must be clear evidence of derivation of – 5. Accept one calculation and no statement about the other.	1
(ii)	**either** s = 0 gives $10t - 5t^2 = 0$ so $5t(2-t) = 0$ so t = 0 or 2. Clearly need t = 2 **or** Time to highest point is given by 0 = 10 – 10t Time of flight is 2×1 = 2 s horizontal range is 40 m as 40 < 70, hits the ground	 B1 M1 A1 M1 M1 A1 B1 E1	 Factorising Award 3 marks for t = 2 seen WWW Dep on 1st M1. Doubling **their** t. Properly obtained FT $20 \times$ **their** t Must be clear. FT **their** range.	5
(iii)	need $10t - 5t^2 = -15$ Solving $t^2 - 2t - 3 = 0$ so $(t-3)(t+1) = 0$ and t = 3 range is 60 m	 M1 M1 A1 M1 A1	[May divide flight into two parts] Equate s = -15 or equivalent. Allow use of ± 15. Method leading to solution of a quadratic. Equivalent form will do. Obtaining t = 3. Allow no reference to the other root. [Award SC3 if t = 3 seen WWW] Range is $20 \times$ **their** t (provided t > 0) cao. CWO.	5
(iv)	Using (ii) & (iii), since 40 + 60 > 70, paths cross (For $0 < t \leq 2$) both have same vertical motion so B is always 15 m above A	E1 E1	Must be convincing. Accept sketches. Do not accept evaluation at one or more points alone. That B is *always* above A must be clear.	2
(v)	Need x components summing to 70 $20 \times 0.75 + 20 \times 2.75 = 15 + 55 = 70$ so true Need y components the same $10 \times 2.75 - 5 \times 2.75^2 + 15 = 4.6875$ $10 \times 0.75 - 5 \times 0.75^2 = 4.6875$	M1 E1 M1 B1 E1	May be implied. Or correct derivation of 0.75 s or 2.75 s Attempt to use 0.75 and 2.75 in two vertical height equations (accept same one or wrong one) 0.75 and 2.75 each substituted in the appropriate equn Both values correct. [Using cartesian equation: B1, B1 each equation: M1 solving: A1 correct point of intersection: E1 Verify times]	5
				18